Appendix A: Results/Documentation from the Chemical Test Section Performance Evaluation of Passive Alcohol Sensors

A Study on the Use and Effectiveness of Passive Alcohol Sensing Devices (PASD)

Phase 1 – Technical Analysis

Part B - Unit Testing

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Introduction

An evaluation of passive alcohol sensing devices (PASD) marketed in the United States was undertaken by the Chemical Test Section (the Section) to evaluate their performance under both laboratory and controlled drinking settings. Professional contacts and a search of the Internet yielded a list of six PASD manufacturers doing business in the United States. These six manufacturers were contacted to determine their willingness to participate in the study. Each of the contacted manufacturers agreed to participate and provided a single device for the duration of the study. Each device was shipped with pertinent documentation including technical data sheets, training videotapes, manuals, etc. Testing was conducted from May through October 2002 by the Section chemist and other Section staff. Section staff was trained by the Chemist in the proper use of each device prior to testing.

General operation of a PASD consists of pointing or directing its sampling port to a subject's mouth from a distance that varies by manufacturer. Depending on the device, the operator instructs or encourages the subject to breathe, blow or speak at the device while an air sample is obtained. The analytical method employed by the devices to detect ethanol is the fuel cell, which is common to other breath alcohol testing devices used in Wisconsin including preliminary breath tests (PBT) and the Intoximeter EC/IR, the State's current evidential breath testing device. The fuel cell then analyzes the sample, quickly providing a result in the form of either a numerical readout, indicator lights which display zero, low, or high amounts of alcohol, or a 'P' (Pass) / 'F' (Fail) display indicating the absence or presence of alcohol, respectively. According to manufacturers literature, the devices are ready for a subsequent test within two to thirty seconds after a negative air sample and within twenty seconds to two minutes after an alcohol-laden air sample is tested.

Methods and Materials

See Page 83, PASD Features, for a comparison of specific features for each unit tested.

A) Laboratory Studies

Accuracy testing was conducted on July 5 and October 18, 2002 in the Section laboratory under tightly controlled conditions. Single analyses of simulated breath at six breath alcohol concentrations: 0.00, 0.02, 0.04, 0.08, 0.10, and 0.20 g/210L, using characterized breath alcohol simulator solutions ((Lot #s 0204, 0105 and 0206, 0106, 0205 and 0207, and 0203, respectively) were tested. These breath alcohol concentrations represent important statutory benchmarks and breath concentrations commonly encountered in traffic enforcement. Human breath was blown into the inlet port of the simulators to produce the samples and towards each PASD from distances of 1, 4, 6, 12, and 18 inches using Guth Model 210021 Simulators at 34 degrees Celsius (SN DR1402, DR1423, and DR1424). Distances were verified with a standard ruler. Immediately before and after testing, each PASD was tested with a 0.100 g/210L simulator solution (Lot #0205), using PASD manufacturers' recommended procedures for confirming calibration. The simulator solutions themselves were tested at the beginning, middle, and end of the testing period with a calibration verified Alco-Sensor IV (Intoximeter, Inc), SN 30794 and 38995.

B) Controlled Dosing Studies

Drinking subject testing was performed with each PASD over three, two-day periods: May 29 - 30, 2002 at the Oregon Community Center, July 9 - 10, 2002 at Janesville Job Center and October 15 - 16, 2002 at the Wisconsin State Patrol Academy, Tomah, in conjunction with routine Breath Examiner Specialist Training. Breath Examiner Specialist Training provides instruction to law enforcement personnel in the proper operation of the Intoximeter EC/IR, Wisconsin's evidential breath alcohol testing instrument. PASD were operated by Section personnel, trained by the Section Chemist in the manufacturers' procedures for routine use. Volunteer subjects were student breath examiner specialists, who, as a routine part of their instruction, volunteer to drink alcoholic beverages thereby providing drinking subjects for other breath examiner specialists in training. These volunteers were apprised of the purpose of the study and proved compliant with the PASD operators throughout the study period. The rooms where the PASD testing was performed were maintained at comfortable draft-free room temperatures. PASD were checked for accuracy using manufacturers procedures both before and after controlled dosing testing using a Guth Model 21002 Simulator with a 0.10 g/210L solution (Lot #0205 or #0207).

Volunteers were provided sufficient alcohol, consumed in one hour, to achieve a maximum breath alcohol concentration of 0.10 g/210L, and were under close supervision by Section personnel. The Intoximeter EC/IRs used in this study were properly calibrated and performed flawlessly throughout the study. Subjects were tested from 35 minutes to 2.75 hours after their last drink, ensuring the subjects had no alcohol in their mouths during testing. EC/IR breath alcohol concentrations of the subjects averaged 0.045 g/210L (range 0.00 to 0.09 g/210L). PASD results were compared to Intoximeter EC/IR results taken within 15 minutes of the PASD tests. An average of 29 people (range 21-34) were tested on each PASD at one, four, and six inches from the subjects' mouths, representing the range of operating distances recommended by the manufacturers. An average of 14 subjects (range 10-17) were also tested with each PASD with samples obtained from a distance of twelve inches.

Additional human subject testing was conducted during the dosing period after observing a 5-minute alcohol deprivation period to evaluate PASD performance in the presence of moderate amounts of mouth alcohol. An average of 30 subjects (range 16-40) were tested on each PASD in this manner, using the manufacturers recommended testing distances or 4 inches where no recommendation is made. At one of the testing sites, the room containing the drinkers was approximately 80 degrees Fahrenheit. A sample of the room's air tested positive for alcohol when testing the CMI AlcoBlow and the Lifeloc FC 10 Plus. For this reason, the testing of these two devices was suspended.

C) Open Container Testing

Samples of headspace air from open beverage containers were analyzed on each PASD over three, two-day periods: May 29 - 30 at the Oregon Community Center, July 9 - 10 at Janesville Job Center, and October 15 - 16, 2002 at the State Patrol Academy, in conjunction with routine Breath Examiner Specialist Training. An average of 27 alcoholic beverages (range 16-33) were tested by

each device. Alcoholic beverages tested included brandy, vodka, rum, and flavored vodkas. These were mixed with sodas (Pepsi Cola, Coca-Cola, RC Cola, 7-Up, Sprite, Sierra Mist, Barq's Root Beer) in diet and regular formulations, lemonade, orange and cranberry juices, or consumed without a mixer. Eighty-two percent of the beverage containers tested contained ice cubes. PASD operators positioned the devices, on average, 3.4 inches (range 1-11) above the liquid surface for testing. The actual alcohol concentration of drinks being tested was not determined.

Results

A) Laboratory Studies

Calibration testing of each PASD both before and after accuracy testing confirmed the units were in good calibration throughout the study. Analysis of simulator solutions used in the PASD study showed no significant depletion of alcohol.

Table 1 contains the accuracy testing results, showing how predictably each PASD could detect alcohol in the simulated breath presented to it from five different distances. Five of the six devices detected alcohol 100% of the time when alcohol-containing breath was presented to the PASD from distances of 6 inches or less. Performance at longer distances decreased to the point that at 18 inches only one-half of the units could detect alcohol 80% of the time or more. None of the PASD manufacturers included in this study recommends PASD at distances greater than 10 inches from the subject in question. Five out of six of the PASD properly detected alcohol in all of the simulated breaths, when samples were obtained within the manufacturers recommended distances.

Five of six of the PASD detected alcohol in simulated breath at six inches or less.

Table 2 is a summary of PASD performance when presented with simulated alcohol breath containing differing breath alcohol concentrations. This data includes all simulated breath samples regardless of distance from the simulator. False positives were evident with only one device, the PAS III Flashlight. The other five PASD correctly detected no alcohol when alcohol-free simulated breath was presented. All devices detected simulated breath alcohol in concentrations of 0.02 - 0.04 g/210L between 60-100 % the time. Performance improved as the concentration of alcohol in the simulated breath increased. Five of the six PASD could detect simulated breath alcohol concentrations of 0.08 g/210L and greater.

PASD detected alcohol in simulated breath at concentrations of 0.02 - 0.04 g/210 from 60% to 100% of the time.

B) Controlled Dosing Studies

Calibration verification of each PASD both before and after controlled dosing studies confirmed the units were in good calibration.

Table 3 summarizes performance of PASD on drinking subjects sampled at four different distances versus contemporaneous Intoximeter EC/IR tests. The Average score listed in Table 3 includes the results of alcohol free breaths measured prior to dosing. The data show that when PASD were used at distances greater than one inch, one-half or more of them failed to detect breath alcohol more than 80% of the time. Operation of the PASD at 12 inches yielded only one device with a greater than 50% chance of detecting alcohol in known drinkers. When used at the manufacturers recommended operational distances, only two devices, the Intoximeter Alco-Sensor III with Quick Draw, and the CMI AlcoBlow detected alcohol in more than eighty percent of the drinking subjects.

When used at recommended distances, only two PASD detected alcohol on more than 80% of the drinking subjects.

Graphs 1 - 6 summarize individual performance of each PASD in comparison to contemporaneous Intoximeter EC/IR tests at all distances studied. In Graphs 1 - 4, the Y axis (vertical axis) duplicates the manner in which each device provides a result. The X axis (horizontal axis) provides a score at each response level.

Graph 1 Alcohol Countermeasures Systems Alcoscan
The Alcoscan provides a result in the form of three colored lights, each predicting a specific range of breath alcohol concentration: Green= 0.000 - 0.019%, Yellow= 0.020 - 0.049 % and Red= greater than 0.049%. This device properly categorized breath alcohol concentrations in 94% of the subjects in the Green range, 43% of the subjects in the Yellow range and 55% of the subjects in the Red range. The numbers of observations in each category were 17, 47, and 47 respectively.

Graph 2 CMI AlcoBlow
The AlcoBlow also provides results in the form of three colored lights, each predicting a specific range of breath alcohol concentration: Green= less than 0.010%, Yellow= 0.010 - 0.020% and Red= greater than 0.020%. This device properly predicted breath alcohol concentrations in 100% of the subjects in the Green range, 33% of the subjects in the Yellow range and 49% of the subjects in the Red range. The numbers of observations in each category were 22, 3, and 22 respectively.

Graph 3 Draeger Safety Alcotest 7410
The Alcotest provides results with a “P” for Pass and “F” for Fail approach. “P” predicts the absence of any alcohol or 0.00 g/210L, while “F” predicts alcohol in any concentration exceeding 0.00 g/210L. The device properly predicted the absence of alcohol in 100% of the persons in the “P” category, and 36% of the subjects in the “F” range, (in our study, 0.01 - 0.09 g/210L), with 18 and 115 observations in each category, respectively. The lower graphic in Graph 3 separates the “F” group into two categories, 0.01 - 0.04 g/210L and 0.05 - 0.09 g/210L to see if any performance improvement would occur at higher breath alcohol concentrations. In the individuals with breath alcohol concentrations of 0.01 - 0.04 g/210L, 33% of them were detected, while 41% of the 0.05 - 0.09g/210L group were detected, with 61 and 54 observations made in these categories respectively.

Graph 4 PAS Systems International PAS III Flashlight

The PAS III Flashlight uses a nine bar display that illuminates successive indicator lights from Green to Yellow to Red, with increasing alcohol concentrations. The first Green bar indicates 0.01 %, the second Green 0.02%, the first Yellow 0.03%, the second Yellow 0.04%, the third Yellow 0.05%, the fourth Yellow 0.06%, the first Red 0.08%, the second Red 0.10 % and the third Red 0.12%. The final two red lights were omitted from the graph, as no experimental data exists at those concentrations. The PAS III Flashlight correctly predicted 100% of the alcohol free subjects, none of the subjects at breath alcohol concentrations of 0.01%, 0.02%, or 0.03%, 7% of subjects at 0.04%, 15% of subjects at both 0.05% and 0.06%, and 33% of subjects at 0.08%. The numbers of observations in each category were 11, 6, 8, 10, 15, 20, 13, and 7. The 2002 instruction manual provides the above indicated display interpretation but, according to Mr. Jarel Kelsey of PAS Systems International, the PAS III Flashlight's ability to predict a person's breath alcohol concentration is being de-emphasized in company training materials. These data support this objective. In addition, Mr. Kelsey indicates that PAS Systems International offers an alternate calibration of the device that would increase sensitivity at lower alcohol concentrations while further reducing the device's ability to predict coexisting breath alcohol concentrations.

Graph 5 Intoximeter Alco-Sensor III with Quick Draw

The Alco-Sensor III is a preliminary breath-testing device (PBT) outfitted with the Quick Draw attachment to allow for passive sampling. Results are displayed in a three decimal place numerical readout. The Alco-Sensor III is a PBT that is approved for use in Wisconsin and is highly accurate and precise when used as a PBT, however that level of performance is drastically reduced with the addition of the Quick Draw attachment. Graph 5 illustrates the relatively poor linear relationship between the EC/IR results and this PASD. A linear regression equation showing perfect agreement between two data sets is: $y = 1.00x + 0.0$. The slope of this linear regression analysis indicates that the Alco-Sensor III with Quick Draw detects about ten percent of a known breath alcohol concentration, with the correlation coefficient (r^2) indicating a very weak relationship between the two sets of data. The manufacturer does not recommend predicting a specific breath alcohol concentration from an Alco-Sensor III with Quick Draw result; these data support that advice.

Graph 6 Lifeloc FC10Plus

The FC10Plus is a preliminary breath-testing device (PBT) with passive sampling capability. Results are displayed in a three decimal place numerical readout. The FC10Plus has not been evaluated in Wisconsin for use as a PBT so performance information in that mode is unavailable. Graph 6 illustrates the linear relationship between the EC/IR results and this PASD. A linear regression equation showing perfect agreement between two data sets is: $y = 1.00x + 0.0$. The linear regression analysis of this data indicates that the FC10Plus predicts approximately seventy percent of a known breath alcohol concentration, while the correlation coefficient (r^2) indicates a weak relationship between the two sets of data. The manufacturer does not recommend predicting a specific breath alcohol concentration from an FC10Plus result; these data support that advice. According to a personal communication with Lifeloc's Mr. Alan Castrodale, future

versions of the FC10Plus will adopt a “Pass/”Fail” mode of reporting, rather than the numerical readout used on the tested unit.

Graphs 1-6 illustrate that PASD’ quantitative abilities, that is, the ability to correctly predict a person’s actual breath alcohol concentration, are poor.

Graph 7 Actively Drinking Subjects
Additional testing on actively drinking subjects showed that five out of six of the PASD detected the presence of alcohol in eighty percent or more of the subjects tested. The sixth PASD, the Alcotest 7410 detected forty five percent of drinking subjects. Measurement of the subjects’ actual breath alcohol concentrations was not possible in this part of the study due to the probability of mouth alcohol in the subjects, and no data was collected on alcohol-free subjects with only mouth alcohol. These data suggest that the presence of mouth alcohol in drinking subjects increases the ability of the PASD to detect any alcohol, regardless of source.

PASD detect alcohol more readily on persons who have recently been drinking.

C) Open Container Testing
Graph 8 Detection of Alcoholic Beverages
Four of the six PASD detected alcohol in more than eighty percent of the drinks that contained alcohol. The other two PASD detected alcohol in less than half the beverages containing alcohol.

PASD vary widely in their ability to detect alcohol in beverages.

Discussion

This study was designed to survey the overall performance of PASD currently on the market in the United States and not to substitute for a more rigorous evaluation that would be conducted before consideration of approval by the Chemical Test Section.

The studies described here were carried out under controlled laboratory conditions, with drinking subjects who were fully cooperative, and by competent PASD operators that were well trained and monitored. Performance of the PASD diminished from the laboratory to the more realistic controlled dosing studies. Reasons for this reduction in performance are not completely clear, but likely include individual variations in the amount and force of air expelled by subjects while talking, breathing, or blowing at the devices. While this variable was not objectively measured, operators’ observations confirm this. Care must be taken in extrapolating these findings to an even less optimal field environment where controlled conditions including training of operators, controlled environmental conditions, cooperative subjects, and the periodic monitoring of device accuracy may not exist.

Table 4 provides a PASD performance summary. PASD are *qualitative* screening devices designed to give a yes/no response to the question of whether alcohol is present on or about a person in question. This distinguishes PASD from PBTs and evidential breath testers that are both capable of providing very

precise and accurate *quantitative* breath alcohol results. Data in this study confirm that the ability of PASD to measure a coexisting breath alcohol concentration is poor. In addition, due to the nature of the PASD sampling mechanisms, the source of any alcohol detected cannot be known with complete certainty. With these limitations in mind, it would be unrealistic to expect any PASD to detect alcohol in one hundred percent of the drinking individuals. The benchmark of eighty percent chosen for this table represents a compromise between a theoretically perfect tool (100% correct) and one that is no better than chance (50% correct). Three PASD performed at 80% percent or better on every measure. These devices include the Intoximeter AlcoSensor III with Quick Draw, the Lifeloc FC10Plus, and the CMI AlcoBlow.

Both breath alcohol simulator and human subject testing included sampling at distances outside the manufacturers recommendations based on the presumption that field conditions may necessitate use outside ideal distances and that operators may err in estimating distances. These data suggest that strict training and adherence to appropriate operational distances will improve PASD performance.

The data collected on actively drinking subjects must be interpreted in light of the fact that five out of six of the PASD manufacturers recommend potential subjects observe a fifteen-minute deprivation period before being tested with a PASD. While the presence of mouth alcohol increases the detection capability of the PASD, the data suggest that if the observation period is not observed, the PASD may detect mouth alcohol instead of alcohol that has been absorbed into the body and given off in the breath. Additional study of alcohol-free subjects with only mouth alcohol would be necessary to further understand the effect of this observation.

Published studies exist on the ethanol content of soft drinks and other beverages the average person would not expect to contain alcohol. These studies have shown trace amounts of alcohol in 'non-alcoholic' beverages. This study included open container testing on a limited number of 'non-alcoholic' beverages; positive tests were obtained on Sprite, Pepsi, Mountain Dew, Coca-Cola, Diet Coke with Lemon, and orange juice. Although limited in scope, these results, along with the previously published data, strongly suggest that individuals relying on a PASD to detect suspected alcoholic beverages be made aware of these findings. In addition, further testing of 'non-alcoholic' beverages is recommended prior to selecting a PASD for open container testing.

Observations on individual PASD

Three PASD exhibited noteworthy behavior within the study period.

1) PASIII Flashlight

   The PASIII Flashlight was more easily overloaded than other PASD in all phases of the testing. This overloading necessitated delays of up to ten minutes while ethanol was cleared from the fuel cell and the device was ready for subsequent tests.

2) Lifeloc FC10Plus

The Lifeloc FC10Plus exhibited one aberrant result when performing open container testing. When the device was placed five inches from a 250 milliliter bottle of Captain Morgan's Rum, the unit charted a maximum reading on its display but returned a reading of 0.000 BAC. This erroneous result was not replicated.

3) CMI AlcoBlow

The CMI AlcoBlow required replacement of batteries on July 10, 2002. Performance of the unit was not affected.

PASD are simple analytical devices designed for use by non-technically trained individuals. The devices are easy to master, as they require only one or two buttons to operate, have simple displays, and according to their manufacturers, require little routine maintenance. They are, however, analytical devices that must be operated strictly according to manufacturers recommendations for best performance. Likewise, they require regular quality control checks, periodic calibration, and occasional replacement of batteries and fuel cells. Furthermore, routine performance monitoring demands additional expertise and equipment or the funds to purchase this service.

Finally, it should be noted that PBTs currently approved for use in Wisconsin have the capability to function in a passive or 'manual' mode. This feature is being utilized in very limited numbers of law enforcement situations where an active PBT test is impractical.

Conclusion

The results of this study indicate the need for caution when considering whether to employ a PASD in law enforcement situations. Performance of PASD varies and even under laboratory conditions they did not approach the dependability expected of breath alcohol testing devices already approved for use in Wisconsin. Persons considering use of a PASD need to be aware of the limitations of PASD and be prepared to conduct additional evaluations to clearly define the field situations in which they are reliable.

Acknowledgments

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PASD Features
WIDOT Chemical Test Section - 2002

Manufacturer	CMI	Alcohol Countermeasures Systems	Draeger Safety, Inc.	Lifeloc	PAS Systems International	Intoximeters, Inc
Model	AlcoBlow	Alcoscan	Alcotest 7410	FC10Plus	PAS III Flashlight	Alco-Sensor III with Quick Draw
Web Address	www.alcoholtest.com	www.acs-corp.com	www.draeger-breathalyzer.com	www.lifeloc.com	www.pasintl.com	www.intox.com
Detector	Fuel Cell	Fuel Cell	Heated Fuel Cell	Fuel Cell	Heated Fuel Cell	Fuel Cell
Sampling Mechanism	Pump	Pump	Pump	Pump	Pump	Fan
Size-Inches	10.5 x 1.9	11.8 x 2.0	9.0 x 2.8 x 1.3	5 x 2.5 x 1.25	13.9 x 1.5-2.2	6.25 x 3.25 x 1.5
Weight-Ounces	10.5	13	17.6	8	32	8
Battery Type	4 "AA"	Rechargeable NIMH	3 "C"	4 "AA"	Rechargeable NiCad Vehicle & AC adapters incl.	9 volt for ASIII, 2 "AAA for QD
Battery Life/# of Tests	2500	>500	500	162 hours / up to 8000 tests	100 hrs w/o flashlight use	300 - ASIII, 2000 - QD
Operating Temp-Fahrenheit	23-104	20-105	23-104	32-104	0-104	32-104
Deprivation Period	No Recommendation	3 min Smoking, 15 min Drinking	15 min Drinking	15 minutes Drinking	Smoking, 15 min Drinking	Smoking, 15 min Drinking
Readout	Zero, Low, High	Green, Yellow, Red	P or F	Numerical	Bar Graph	Numerical
Readout Interpretation	Zero=green= 0.010 %, Low=Amber=0.010 - 0.020 %, High= Red=>0.020 %	Green=Zero=0.00-0.019%, Yellow=Low= 0.020-0.049%, Red=High>0.049%	P= Pass, F=Fail	Any positive number displayed indicates the presence of alcohol.* (personal communication with A. Castrodale)	1 green=0.01%, +1 green=0.02%, + 1 yellow=0.03%, +1 yellow=0.04%, + 1yellow =0.05%, +1 yellow=0.06%, +1 red=0 .08%, +1 red=0.10%, + 1 red=0.12 %*	Any positive number displayed indicates the presence of alcohol.
Analysis Time	3-5 sec	"Immediate"	5 sec	< 10 sec	5-10 sec	10 sec
Reset Time after Zero Test	2 sec	< 30 sec	5-7 sec	Immediate	Immediate	3 sec
Reset Time after Positive Test	<20 sec@ >0.200%	< 60 sec@ >0.100%	Concentration dependent	within 30 sec	30 sec - 2 minutes	15 sec- 2 minutes
Calibration Frequency	None recommended	9-12 months	Once/year	Once/year	As Accuracy Checks Indicate	As Accuracy Check Indicates
User Calibration	No	Yes	After training/certification	Yes	Yes	Yes
Accuracy Checks	"Periodic"	Per agency 'policy'	Per "agency guidelines"	Per agency policy	Every six months	Weekly/monthly
Open Container Tests	Yes	Yes	Yes	Yes	Yes	Yes
Warranty	1 yr parts/labor	1 yr materials, workmanship	1 yr parts/labor	1 yr parts/labor	1 yr materials, workmanship	1 yr materials, workmanship
Other Modes	Active	Active	Active and Manual	Auto and Manual	None	Active and Manual
Recommended Testing Distance	1"	4-6"	No recommendation	4"	Less than 10" 5-7" optimal	4 "
Subject Instructions	Breathe out or talk	Exhale steadily	No recommendation	Blow constant breath	Blow or talk at unit	Blow towards unit
PBT Capability	No	No	No	Yes	No	Yes
$$/unit - volume discounts may Other Alcohol Detection	$275	$495	$425	$580	$615	$500 complete
Products Available P =PBT, I=IID, E=Evidential, D=Personal/Disposable	P, E	P, I, E, D	P, I, E, D	P, I, E, D	D	P, E
Data collected from manufacturers' literature, web sites and personal communications				* Future units will report in a Pass/Fail format.	* Calibration can be adjusted to increase sensitivity of unit	

Table 1
PASD Detection of Simulated Breath Alcohol at Five Distances

Device	1 inch	4 inches	6 inches	12 inches	18 inches
QuickDraw	100.0%	100.0%	*100.0%*	*80.0%*	*60.0%*
Alcoscan	100.0%	100.0%	100.0%	*60.0%*	*20.0%*
FC10Plus	100.0%	100.0%	*100.0%*	*80.0%*	*100.0%*
AlcoBlow	100.0%	*100.0%*	*100.0%*	*100.0%*	*80.0%*
Alcotest	100.0%	100.0%	100.0%	80.0%	60.0%
PAS III	*83.3%*	*100.0%*	100.0%	*83.3%*	*100.0%*

Shaded area denotes outside of manufacturers' recommendations for use.

Table 2
PASD Detection of Six Simulated Breath Alcohol Concentrations

Device	0.00	0.02	0.04	0.08	0.10	0.20
QuickDraw	100%	60%	80%	100%	100%	100%
Alcoscan	100%	60%	60%	80%	80%	100%
FC10Plus	100%	80%	100%	100%	100%	100%
AlcoBlow	100%	80%	100%	100%	100%	100%
Alcotest	100%	60%	80%	100%	100%	100%
PAS III	*40%*	100%	100%	100%	100%	100%

Shaded area denotes solution containing no ethanol identified as alcohol.

Table 3

PASD vs Intoximeter EC/IR with Drinking Subjects

Device	1 inch	4 inches	6 inches	12 inches	**Average***	**Alcohol-free breaths****
QuickDraw	100.0%	88.9%	*82.1%*	*70.0%*	86.0%	100.0%
Alcoscan	96.6%	85.2%	71.4%	*42.9%*	79.5%	100.0%
FC10Plus	90.3%	79.4%	*71.9%*	*29.4%*	76.5%	100.0%
AlcoBlow	100.0%	*79.4%*	*21.9%*	*0.0%*	63.2%	100.0%
Alcotest	88.2%	31.3%	6.3%	6.3%	45.1%	100.0%
PAS III	*95.2%*	*90.5%*	68.2%	*18.2%*	77.9%	100.0%

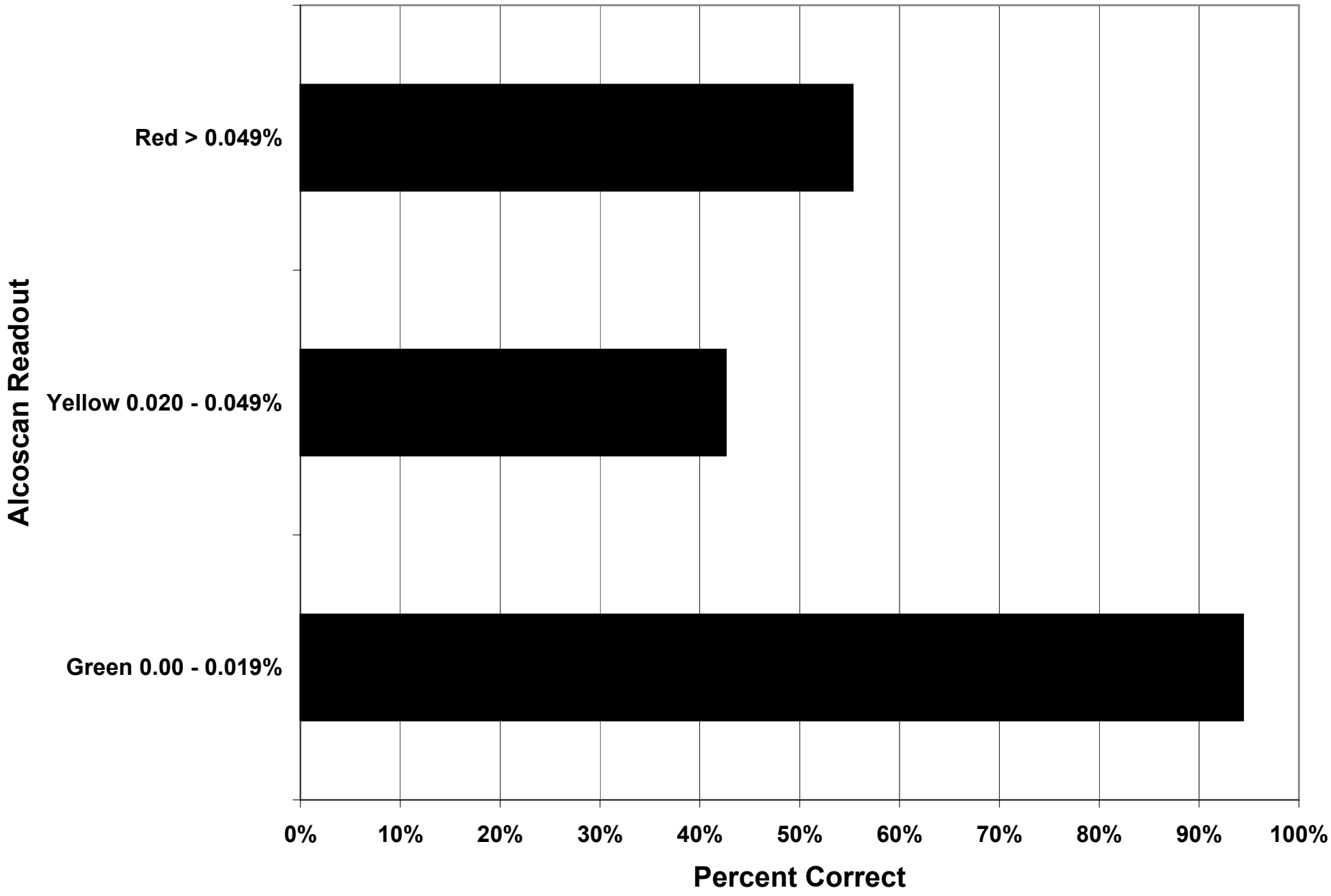
Shaded area denotes outside of manufacturers' recommendations for use.

* Includes alcohol-free breaths

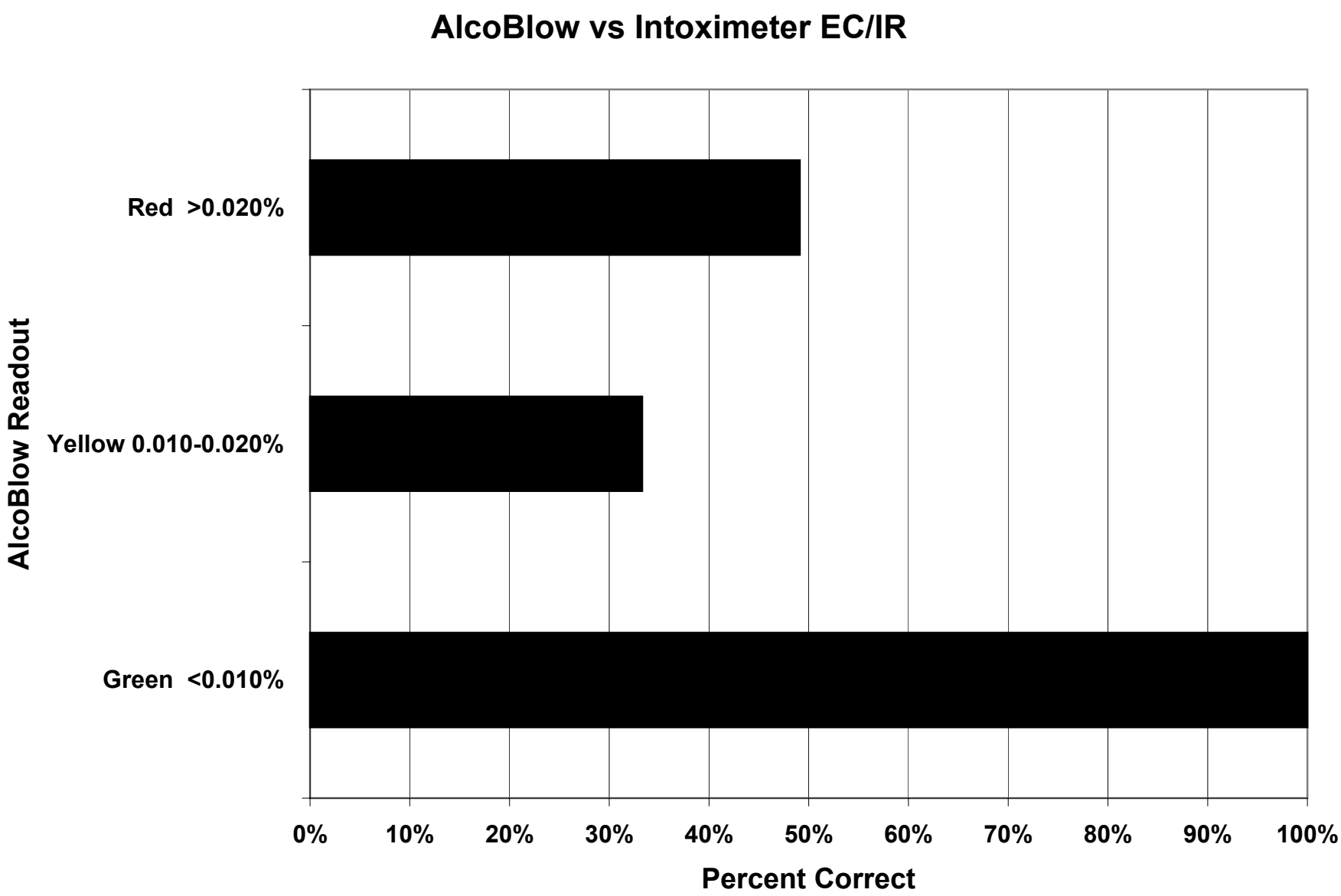
**At manufacturer's recommended distance

Graph 1

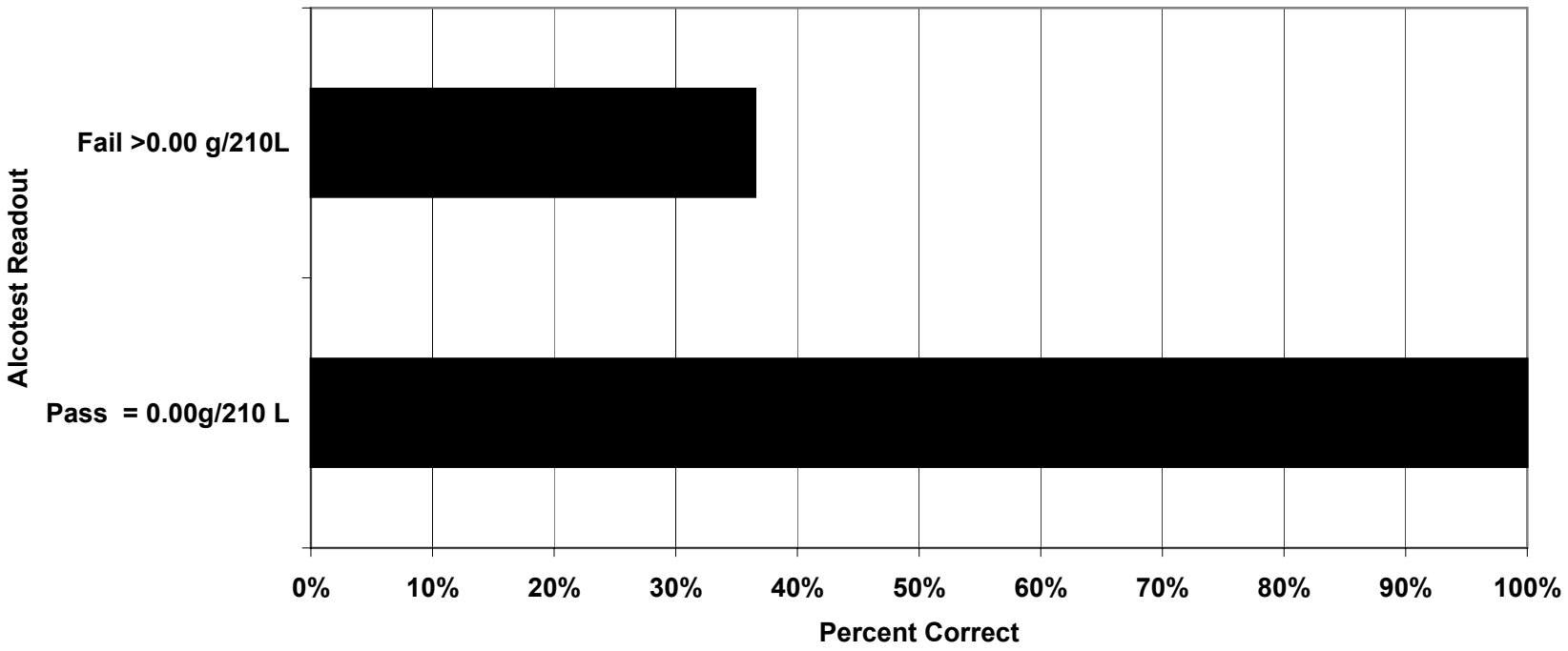
Alcoscan vs Intoximeter EC/IR

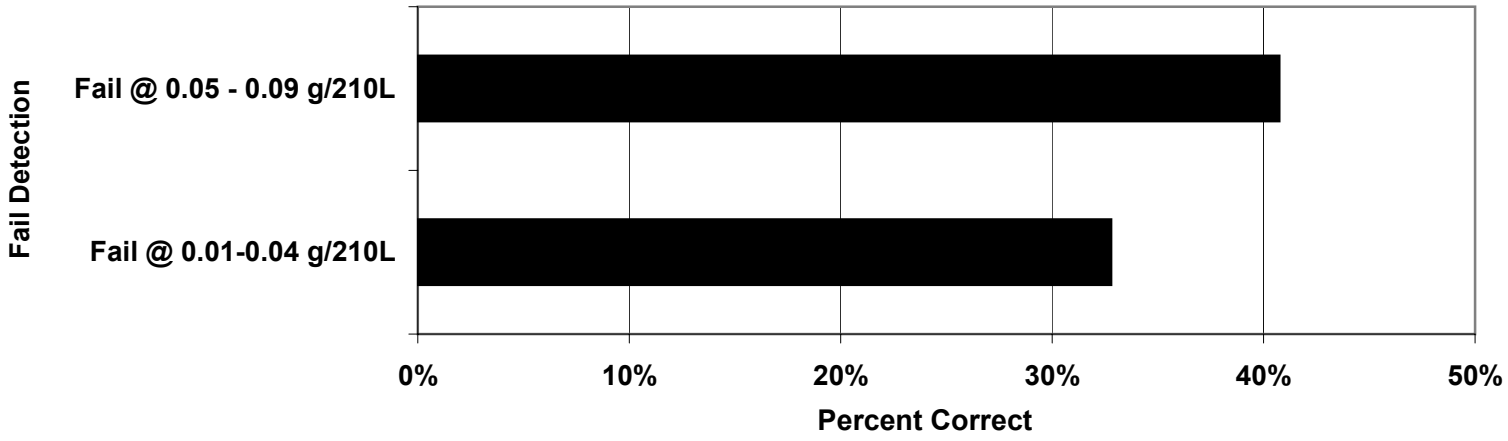


Graph 2


AlcoBlow vs Intoximeter EC/IR
AlcoBlow Readout
Red >0.020%
Yellow 0.010-0.020%
Green <0.010%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent Correct

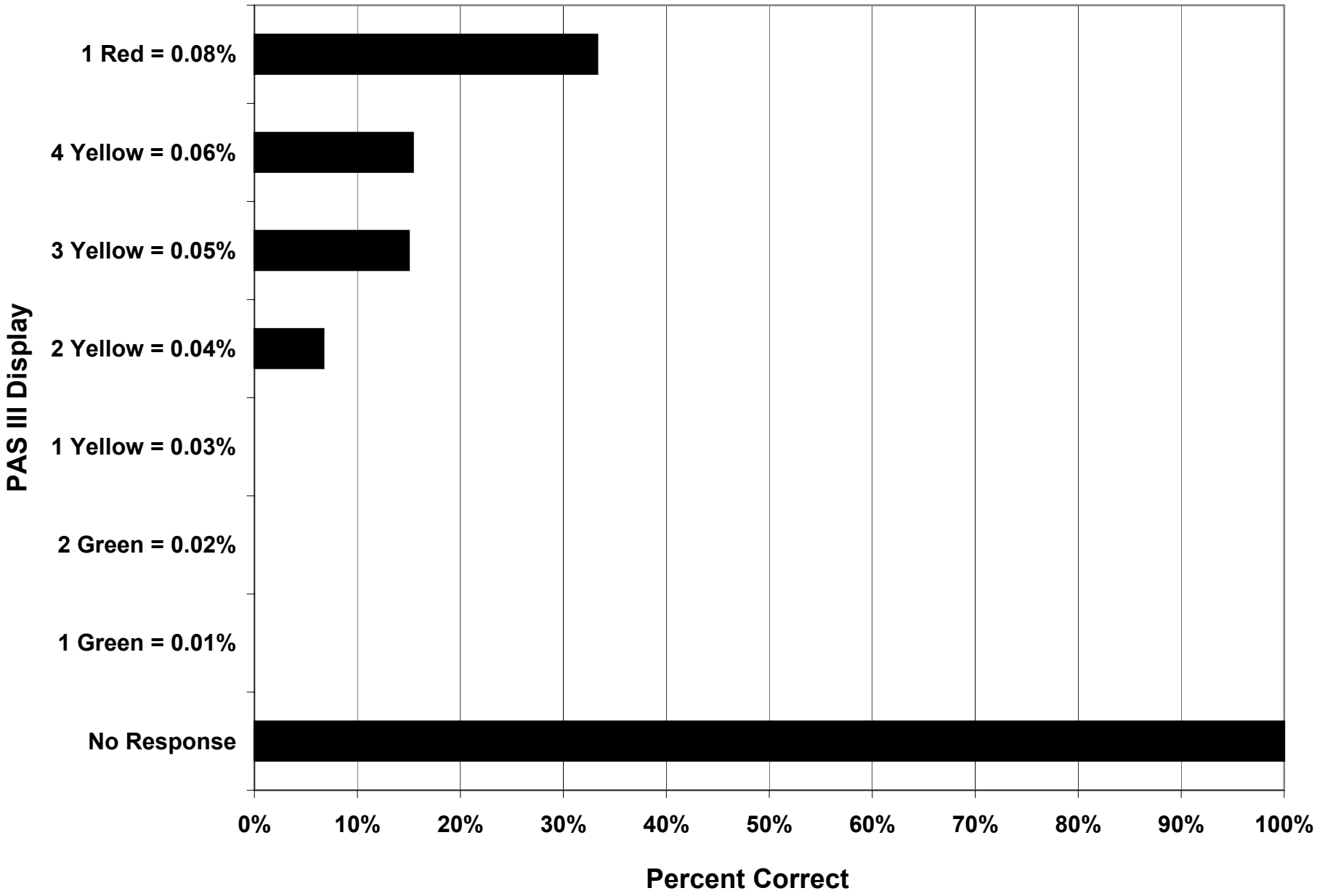
Graph 3
Alcotest vs Intoximeter EC/IR





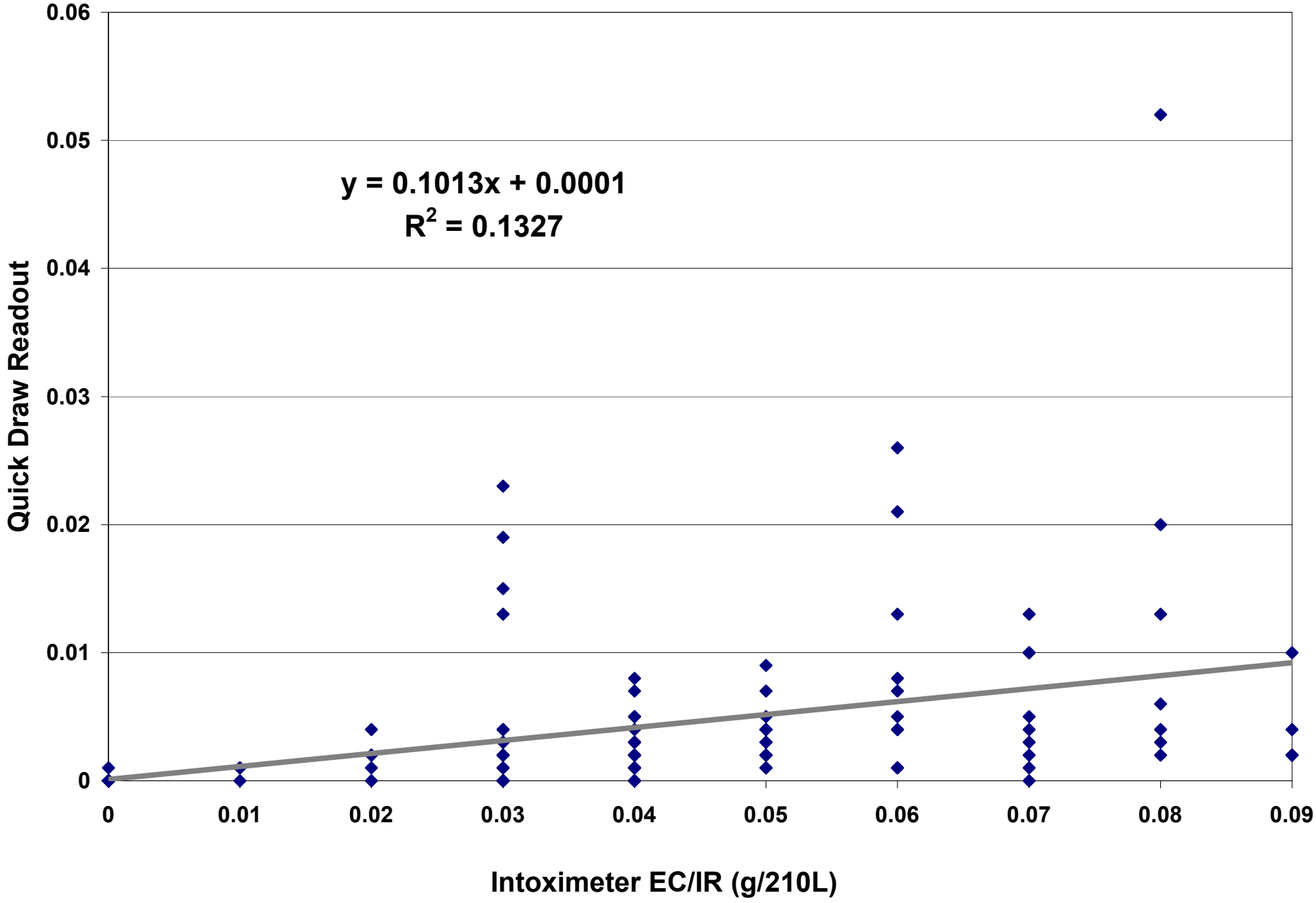
Graph 4

PAS III Flashlight vs Intoximeter EC/IR



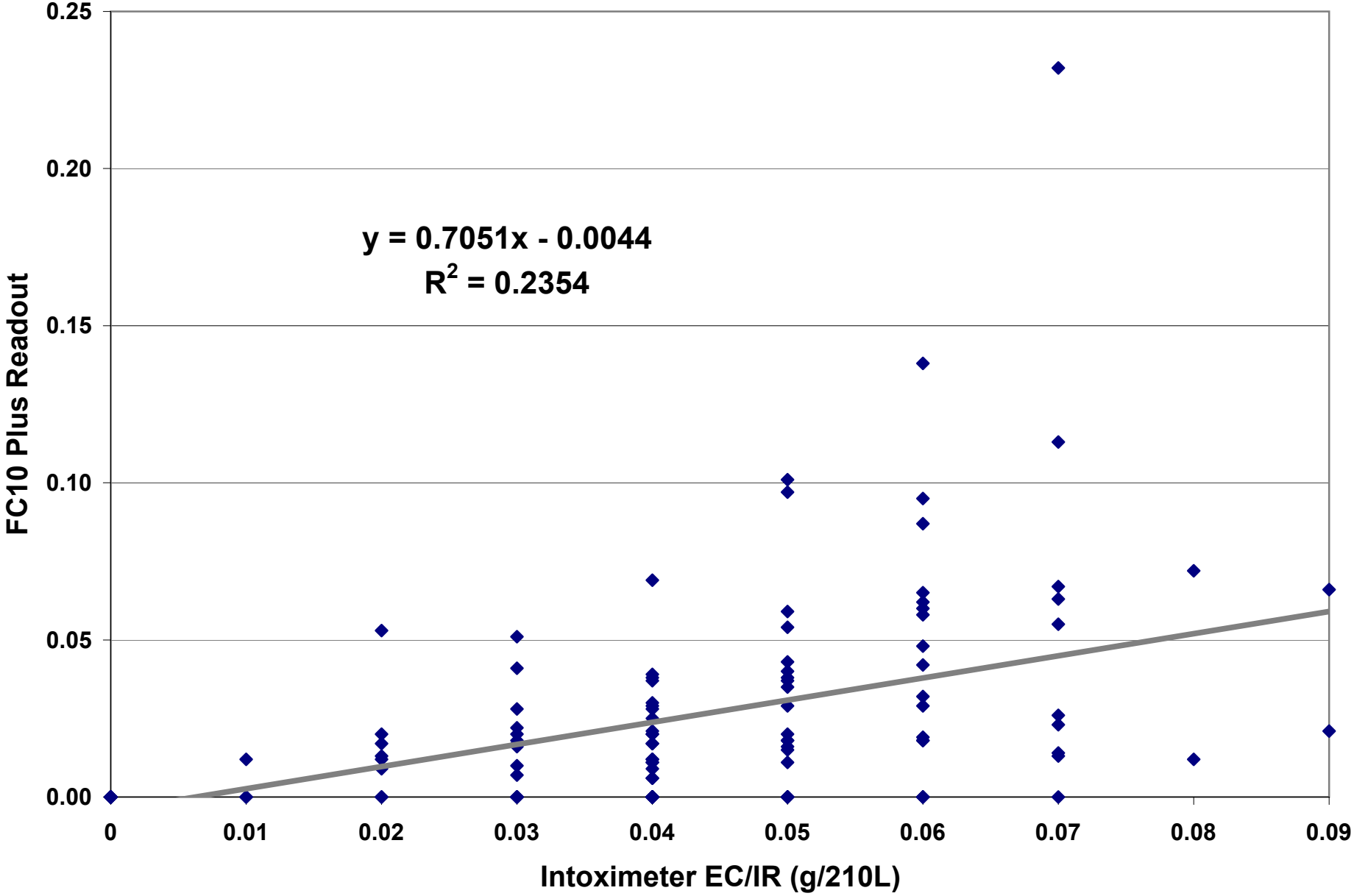
Graph 5

Alcosensor III with QuickDraw vs Intoximeter EC/IR



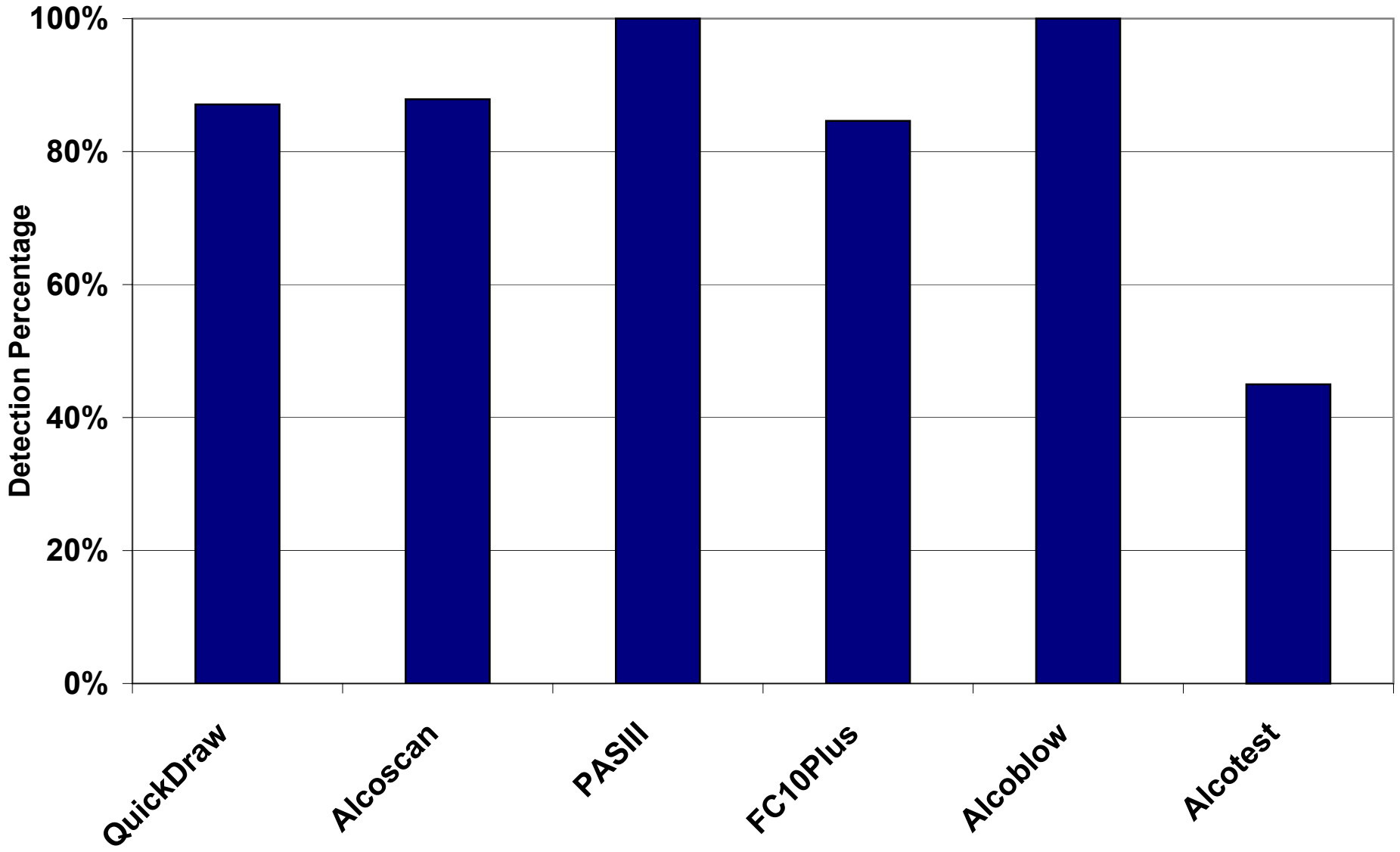
Graph 6

FC10 Plus vs Intoximeter EC/IR



Graph 7

PASD Detection of Actively Drinking Subjects



Graph 8

PASD Detection of Alcoholic Beverages

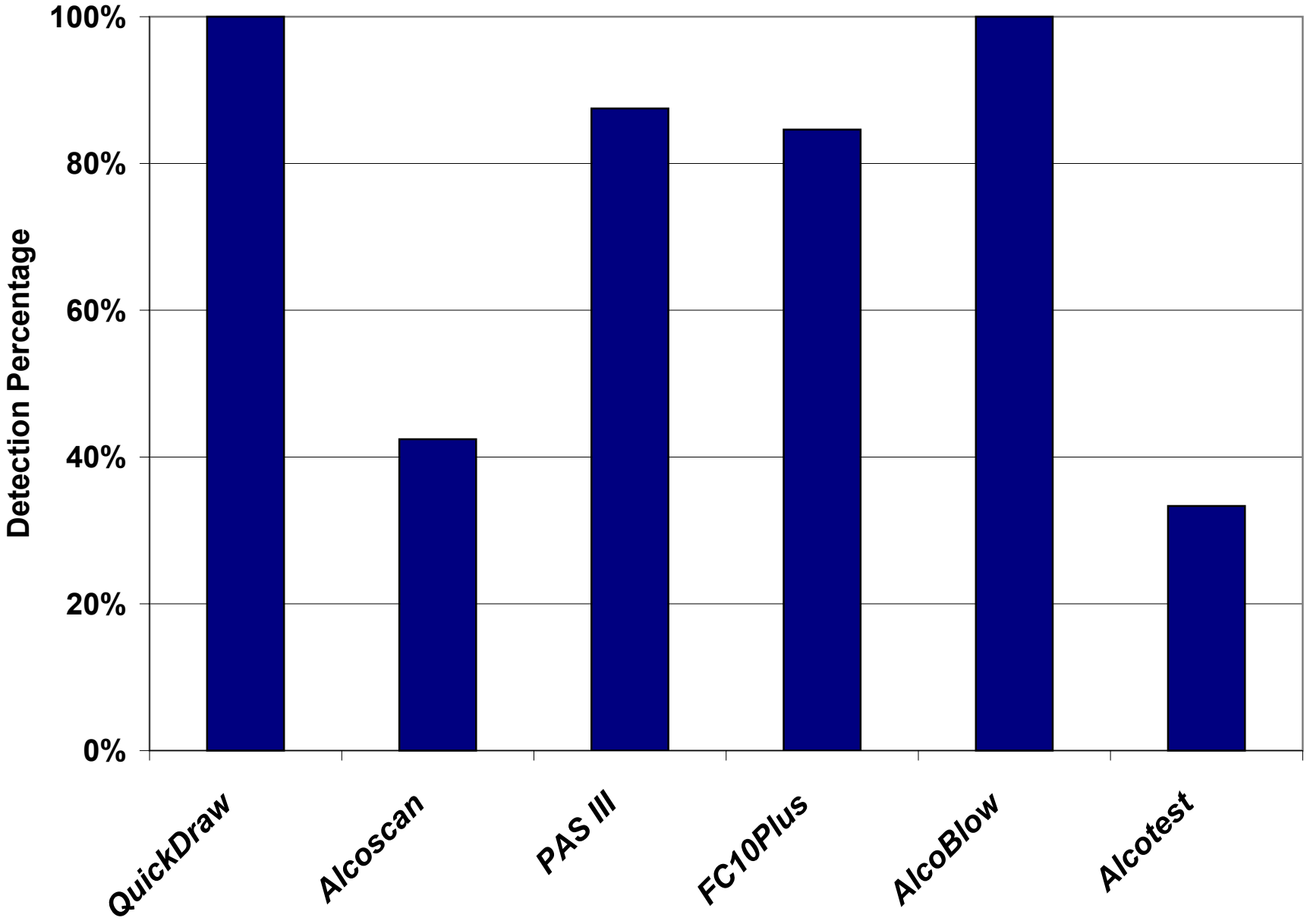


Table 4

PASD 80 % Performance Summary

Device	Lab Simulation at 1-12 inches	Lab Simulation at 0.00 - 0.20 g/210 L	Human Subjects	Active Drinking	Open Container	*Grand Score*
Alcosensor III with QuickDraw	**Y**	**N**	**Y**	**Y**	**Y**	***80%***
Alcoscan	**N**	**N**	**N**	**Y**	**N**	***20%***
FC10Plus	**Y**	**Y**	**N**	**Y**	**Y**	***80%***
AlcoBlow	**Y**	**Y**	**Y**	**Y**	**Y**	***100%***
Alcotest	**Y**	**N**	**N**	**N**	**N**	***20%***
PAS III	**Y**	**N**	**N**	**Y**	**Y**	***60%***